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REVIEW ARTICLE

Selection procedures in sports: Improving predictions of athletes' future performance

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Abstract

The selection of athletes has been a central topic in sports sciences for decades. Yet, little consideration has been given to the theoretical underpinnings and predictive validity of the procedures. In this paper, we evaluate current selection procedures in sports given what we know from the selection psychology literature. We contrast the popular clinical method (predictions based on overall impressions of experts) with the actuarial approach (predictions based on pre-defined decision rules), and we discuss why the latter approach often leads to superior performance predictions. Furthermore, we discuss the “signs” and the “samples” approaches. Taking the prevailing signs approach, athletes' technical-, tactical-, physical-, and psychological skills are often assessed separately in controlled settings. However, for predicting later sport performance, taking samples of athletes' behaviours in their sports environment may result in more valid assessments. We discuss the possible advantages and implications of making selection procedures in sports more actuarial and sample-based.

Keywords: Actuarial judgment, clinical judgment, ecological dynamics, samples approach, signs approach, talent

Highlights

- Selection procedures in sports are reviewed through the lens of selection psychology.
- Across sports, selection decisions are mostly based on overall impressions of scouts and trainers (clinical judgment), whereas using explicit decision rules (actuarial judgment) often leads to better performance predictions.
- When systematically assessing athletes, their skills are often tested separately in a standardized setting (signs approach), whereas assessing athletes based on their behavior in a representative context (samples approach) may lead to more powerful performance predictions.
- Based on insights from selection psychology and sport science, we postulate that researchers and practitioners should apply more actuarial judgment, and design more sample-tests to improve selection procedures in sports.

In sports, performance prediction is critical for the selection of athletes. Selection may be aimed at short-term goals, such as the selection of players for the next match, but it may also be aimed at long-term outcomes. Examples of the latter are the selection of youth athletes to decide who can stay in a club's talent-development programme, or the prediction of who can reach excellent performance levels in 10 years. For athlete selection, two issues are essential: (a) What kind of performance do we want to

predict? and (b) what methods can best be used to predict that performance? In this paper, we describe that there is a gap between insights from the scientific literature on selection, and the way in which athletes are selected in reality. As we discuss below, the insights from selection psychology can provide guidance for future directions in performance prediction and selection in sports. We specifically consider two important topics: How to combine information in order to make predictions and decisions, and what

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kind of information to include in decisions to optimise predictions.

Judging athletes

The selection of athletes is often performed by scouts or coaches. For example, they observe athletes in training sessions or games and decide whether or not to include the athlete in their youth talent-development programme, or in the line-up for an upcoming tournament, match, or race. An important issue is how scouts and coaches make these decisions (Johansson & Fahlén, 2017; Larkin & Reeves, *in press*). In most cases, they make a decision based on their *overall* impression of the athlete in their minds (Christensen, 2009; Lewis, 2003). These impressions may comprise many different observations and variables, for example, the attitude of the athlete, the technical skills, or even the “X-factor” of the athlete (Larkin & O’Connor, 2017).

In selection psychology, there is a rich literature in which it is argued that we should be cautious when using such “clinical judgments” (Dawes, Faust, & Meehl, 1989). Because much information often has to be combined to make a decision, the rater, in this case the scout or coach, likely falls prey to different sorts of errors and biases. This may lead to (a) less accurate decisions and (b) disagreements between raters who have different opinions. Sports judges’ proneness to bias was already discussed 40 years ago, when Ansorge and colleagues revealed a “reputation bias” in the scores provided by gymnastic judges (Ansorge, Scheer, Laub, & Howard, 1978). They showed that judges scored female gymnasts significantly higher when they appeared in the fifth position of their team (typically occupied by the best gymnast) than when these same gymnasts appeared in the first position. In line with this finding, Findlay and Ste-Marie (2004) found that figure skating judges who knew about the positive reputations of particular figure skaters, evaluated those skaters better than judges who were unaware of the skaters’ reputations. Apart from reputations, an athlete’s appearance in terms of clothing (Greenlees, Bradley, Holder, & Thelwell, 2005), body language (Furley, Dicks, & Memmert, 2012), and skin colour (Stone, Perry, & Darley, 1997) can also significantly influence the impressions people form of athletes. These findings converge with recent results by Pappalardo, Cintia, Pedreschi, Giannotti, and Barabasi (2017), who investigated the cognitive process underlying soccer performance evaluation. They used machine learning to create an artificial judge that accurately reproduced human evaluation, and demonstrated that human judges are biased towards diverse contextual elements.

In line with the above findings, a recent study demonstrated how coaches can strongly disagree when selecting players. Wiseman, Bracken, Horton, and Weir (2014) asked (ice) hockey coaches to generate a list of the top five and bottom five players based on their impression of these players’ performance in video clips. Nine of the 13 players were placed in *both* the top and bottom groups. This is in accordance with the robust finding that people, including experts such as scouts and coaches, are not good at consistently integrating and weighting relevant sources of information to make judgments (Dawes, 1979; Grove, Zald, Lebow, Snitz, & Nelson, 2000; Kahneman, 2011; Kuncel, Klieger, Connelly, & Ones, 2013; Pappalardo et al., 2017).

In order to increase the quality of the selection process, trainers or scouts can make their decision rules explicit and possibly add a particular weight to certain athletic skills (Musculus & Lobinger, 2018). Using such rules for decision-making is called “actuarial judgment”. In many studies in the selection psychology literature, it has been shown that actuarial judgment results in better performance predictions than clinical judgment (e.g. Ægisdóttir et al., 2006; Bishop & Trout, 2002; Dawes et al., 1989; Grove et al., 2000; Kuncel et al., 2013). Conveniently, the weights assigned to certain qualities included in decision rules do not necessarily have to be optimised based on statistical analyses of large datasets. The consistent application of a decision rule alone already improves predictions and decision-making, because it decreases the likelihood of biased judgments (Dana & Dawes, 2004; Dawes, 1979). This conclusion has been replicated across various domains, such as the prediction of academic performance, the quality of wine, marital happiness, and psychological and medical diagnoses (Benson & Newman, 2010; Bishop & Trout, 2002; Grove et al., 2000; Kahneman, 2011; Kuncel et al., 2013; Schwab, 2008; Swets, Dawes, & Monahan, 2000).

Let us consider a simple example of actuarial judgment in sports, soccer in this case. When soccer scouts are looking for an attacking left wing-back, they may score a player on forward dribbling actions and on successful passes. If successful passes are considered more important, these can be weighted 60%, whereas dribbling actions can be weighted 40%. Decisions are now based on combining the weighted scores on the dribbling and successful passes, and not on any implicit subjective impressions, such as whether or not the player has the X-factor (Larkin & O’Connor, 2017). To our knowledge, studies explicitly comparing clinical with actuarial judgment in sports have not been conducted yet. However, given that (a) expert judges in different sports are prone to cognitive biases (e.g.

Ansorge et al., 1978; Findlay and Ste-Marie, 2004; Pappalardo et al., 2017), (b) sport coaches tend to disagree on the quality of players when applying clinical judgment (e.g. Wiseman et al., 2014), and (c) predictions based on actuarial judgment often outperform those based on clinical predictions across different domains (e.g. Ægisdóttir et al., 2006; Grove et al., 2000), one could expect more accurate performance predictions in sports when decisions are made based on pre-specified decision rules (cf. Ægisdóttir et al., 2006; Dawes et al., 1989).

In sports, decision rules can be used to combine information from expert ratings (Musculus & Lobinger, 2018), but it is also possible to use these rules when direct measures of sport performance are collected (e.g. continuous position data, see Couceiro, Dias, Araújo, & Davids, 2016; Frencken, Lemmink, & Delleman, 2010; Link & Hoernig, 2017). Yet, for the majority of athletes, this type of data is often unavailable. Then, athletes may be asked to participate in more simple assessments that provide information on the skills considered to be important by the scout, coach, and/or club. An important question to address here is what kind of information should be collected? In other words, what kinds of tests should be administered when assessing the skills of athletes?

Assessing athletic skills

In virtually all sports, researchers and practitioners acknowledge the multidimensionality of athletic performance (e.g. Phillips, Davids, Renshaw, & Portus, 2010; Vaeyens, Lenoir, Williams, & Philippaerts, 2008). Therefore, in the context of assessment, this multidimensionality is often taken into account (e.g. Elferink-Gemser, Visscher, Lemmink, & Mulder, 2004; Huijgen, Elferink-Gemser, Lemmink, & Visscher, 2014; Larkin & O'Connor, 2017; Matthys et al., 2011; Reilly, Williams, Nevill, & Franks, 2000; Woods, Raynor, Bruce, McDonald, & Robertson, 2016). Yet, the way in which athletes' sets of skills are assessed can differ considerably. The prevailing approach is that skills are tested in isolation in order to obtain a reliable assessment of the skill in question. For instance, if a field hockey player needs to be fast, have strong dribbling skills, and be highly motivated, one could let him or her perform a dribbling test, sprint test, and a questionnaire assessment on motivation (e.g. Elferink-Gemser et al., 2004). In terms of selection psychology, this means that one attempts to measure distinct traits or skills that may predict later criterion behaviour. This approach is called the "signs approach" (Niessen, Meijer, & Tendeiro, 2016; Wernimont & Campbell, 1968).

The selection psychology literature distinguishes the signs approach from the "samples approach". In

a samples approach, one attempts to sample behaviour that mimics the criterion behaviour as closely as possible (Wernimont & Campbell, 1968). Because the sampled behaviour is closer to the performance behaviour (criterion), it likely provides a better prediction of future performance than the scores on signs that are assessed in separate tests (Asher & Sciarrino, 1974; Lievens & De Soete, 2012). This is especially the case in populations that are relatively homogenous when it comes to their performance levels (Lievens & Patterson, 2011), as is the case with elite (youth) athletes. The suggestion that tests based on samples are good predictors for future performance has been shown in different achievement contexts, mostly work and education (e.g. Niessen et al., 2016; Sackett, Shewach, & Keiser, 2017; Schmidt & Hunter, 1998).

Recently, Lyons, Hoffman, Michel, and Williams (2011) introduced the sign versus samples discussion in sports (i.e. in the National Football League – NFL). They collected scores on different ability tests that are typically used to select NFL players, namely speed-, power-, and agility tests. In addition to these signs, the authors collected the last year of collegiate performance data that were considered as the samples. In contrast to the signs, the samples significantly predicted players' performance across the following four NFL years (see also Feltz, 1982, 1988; Feltz & Mugno, 1983; Fitzsimmons, Landers, Thomas, & Van der Mars, 1991; O'Connor, Larkin, & Mark Williams, 2016, for empirical evidence that previous sports performance is the best predictor of future performance).

Combining selection psychology with theory and practice in sports

Given the current knowledge from selection psychology, we conclude that the best selection procedures are based on actuarial judgment, and that sample-based tests are powerful tools to predict later criterion behaviour, in particular in homogeneous athletic populations. However, actuarial judgment- and sample approaches are *not* mainstream in sports, which may be explained by the prevailing intuitive and theoretical views that have a closer connection to the clinical and signs approaches. Intuitively, experts such as scouts or trainers in sports are considered to make the best and most reliable judgments in their field (e.g. Johansson & Fahlén, 2017; Larkin & Reeves, *in press*). These experts are often former professionals and it is assumed that they have unique knowledge of their sports. Therefore, they could make unique observations that cannot be made by non-experts (cf. Kaufman, Baer, Cole, & Sexton, 2008), and cannot be captured by statistics

(e.g. Dawes, 1979; Highhouse, 2008; Kuncel et al., 2013). As a consequence, scouts and coaches often do not use concrete pre-specified decision rules (e.g. Christensen, 2009; Johansson & Fahlén, 2017).

Furthermore, researchers and practitioners tend to employ sign-tests to systematically assess the skills of athletes. The underlying idea is that we should search for performance characteristics that are related to athletic performance and performance development (i.e. future performance). In other words, there are probably particular skills and traits that we can identify, and which are the driving force of future performance. We should therefore define these characteristics and find a way to test them separately, with as little confounding influences as possible (e.g. Elferink-Gemser et al., 2004; Lyons et al., 2011; Reilly et al., 2000; Woods et al., 2016). From a selection psychology perspective, this entails that particular kinds of signs, such as being fast, demonstrating endurance capacity, and being motivated, are expected to have high predictive validity for the to-be-demonstrated performance.

In general, we do not deny that signs may have predictive validity in particular sports contexts, especially when the population is heterogeneous. For instance, when selecting rowers, measuring length (sign 1), sitting height (sign 2), and strength (sign 3) in a large sample of 18-year old students can be a relatively economic way to make a first selection of who may reach excellent performance in the future (Kerr et al., 2007). However, research increasingly suggests that the theoretical mechanism underlying sports performance is characterised by intertwined skills that are contextually embedded (e.g. Den Hartigh, Van Dijk, Steenbeek, & Van Geert, 2016; Phillips et al., 2010; Pinder, Davids, Renshaw, & Araújo, 2011). Therefore, in assessment procedures for performance prediction the person–environment interactions should ideally remain intact.

One theoretical perspective in the sport science literature that particularly emphasises the idea that athletic skills should not be considered in isolation of contextual constraints is the ecological dynamics approach (e.g. Araújo, Davids, & Hristovski, 2006; Vilar, Araújo, Davids, & Button, 2012). Among others, this approach assumes that (i) a key requisite of skilled sports performance is to pick up, and act upon, the opportunities for action offered by the environment (i.e. affordances) and (ii) patterns of behaviour emerge through ongoing interactions among constraints at the levels of the performer, task, and environment. Although the ecological dynamics approach has primarily been applied to understanding coordinated performance, learning, and development, their underlying principles seem to provide a logical fit with the samples approach as used in selection.

Let us provide a brief illustration of a signs and samples approach to assess athletes' skills in the context of soccer. Assume that a soccer coach wants to assess the skills of a group of players, and would like to start with assessing the dribbling skills. One method the coach could employ is to construct separate skill-tests in controlled settings, in order to measure physical and psychological signs. In the first test, the athletes need to dribble around cones in order to measure their dribbling skills, which are assumed to relate to their dribbling skills they need to demonstrate in (elite-level) soccer games. A second method that the scout could employ is sampling the players' behaviours during a game. In a sample-based test, the players' dribbling skills are embedded in the way they adapt to the changing positions of team members, opponents, and their own position relative to the other players on the field. An example of a context in which the players' dribbling skills could be assessed is a small-sided game (cf., Davids, Araújo, Correia, & Vilar, 2013; Frencken, Lemmink, Delleman, & Visscher, 2011; Sampaio, Lago, Gonçalves, Maçãs, & Leite, 2014). Small-sided games are simplifications of actual games that preserve the crucial dynamic athlete–environment interactions. During these games, the skills of the players can be assessed using local position measurement systems (e.g. Frencken et al., 2010) or notational analysis systems (e.g. Van Maarseveen, Oudejans, & Savelsbergh, 2017).

Conclusion and practical recommendations

The selection of athletes is pivotal to many sport clubs and organisations, but the empirical and theoretical underpinnings have received scant attention. In this article, we discussed relevant knowledge from the domain of selection psychology, and connected that knowledge to theory and practice in sports. For future research on athlete selection, we believe that much may be gained, as prevailing selection procedures often are based on suboptimal practices according to the selection psychology literature (i.e. clinical and signs approaches). Therefore, we propose that researchers and practitioners should (a) move from clinical judgment to actuarial judgment and (b) design more sample tests for performance prediction.

An actuarial approach could be based on the employment of advanced positional data analysis (e.g. Couceiro et al., 2016), but also on a simple scoring system (e.g. McIntosh, Kovalchik, & Robertson, *in press*; Van Maarseveen et al., 2017). As an example, imagine that scouts will visit youth amateur matches to select players for a basketball

club. Using a simple, actuarial scoring system, each player's skills (e.g. dribbling, shooting, moving) are rated on a five-point Likert scale, and the player's final score is then based on a pre-defined rule of the combinations of the scores obtained on the individual skills. These rules may be based on the previous literature, but may also be based on the type of player that the scout (or club) is looking for. Related to the latter, using actuarial judgment does *not* mean that the scout is not important and that his or her opinion becomes irrelevant. On the contrary, trainers or scouts can provide valuable input to the development and evaluation of the actuarial scoring system – parameters and weights – to be used (e.g. Musculus & Lobinger, 2018; Pappalardo et al., 2017).

To perform actuarial judgment in a performance context, Kahneman (2011) has provided the following concrete guidelines. First, determine a set of relevant variables to measure. These are preferably relatively easy to assess, with a maximum of seven variables. Second, determine how you will combine the variables, for instance, do some variables have more weight than other variables? Third, determine how these variables will be scored (e.g. on a five-point Likert scale). Fourth, combine the scores based on the pre-defined formula. Fifth, use the final score to make your selection decisions. Although Kahneman formulated these guidelines based on his findings in the Israeli Army, this step-wise process could also facilitate the implementation of actuarial judgment in selection procedures in sports.

When introducing a sample test, the following two ingredients are important. First, from the perspective of selection psychology, information with the highest validity tends to have a close correspondence to the criterion that is being predicted (Asher & Sciarrino, 1974). Therefore, one needs to take a sample of behaviour, which is representative for the (later) performance that is expected from the athlete. Accordingly, the second ingredient is that the dynamic athlete–environment relations remain intact in the selection situations (cf. Pinder et al., 2011). Which kinds of behaviours are sampled depends on the criterion behaviour one aims to predict. Given the complexity of sport performance, we believe that the ultimate challenge is to discover a higher order sample metric that constitutes a mixture of relevant skills in the sport of interest (cf. Couceiro et al., 2016; Frencken et al., 2011). As an example, in interactive team sports a macro-level variable could be a player's positioning with and without the ball, relative to other players on the field (cf. Link & Hoernig, 2017). Such a measure contains different kinds of skills and their interactions, such as physical skills (movement speed), psychological skills (direction and intensity of

efforts – motivation), within the athlete's performance environment to which he or she needs to attune his or her actions. Obviously, the higher order metric should be scored in an actuarial way in order to optimise the accuracy of the assessment.

As a final note, while the literature suggests that actuarial approaches are superior in predicting future performance, and that sample-based assessments often outperform sign-based assessments, the time scale of prediction will most likely play a role in terms of the predictive power (e.g. Abbott, Button, Pepping, & Collins, 2005; Baker, Schorer, & Wattie, 2017; Den Hartigh et al., 2016; Vaeyens et al., 2008). In general, when selecting athletes for matches or races in the near future, the predictive power of the selection method can be strong (Lyons et al., 2011). However, prediction becomes increasingly difficult when the to-be-predicted performance lies further in the future (e.g. Barreiros, Côté, & Fonseca, 2014; Den Hartigh et al., 2016; Vaeyens et al., 2008), also when applying a samples approach (Lyons et al., 2011). One reason for this is that currently relevant athletic skills may become less relevant, and vice versa, as the demands of a particular sport change (e.g. Baker et al., 2017; Sarmiento, Anguera, Pereira, & Araújo, 2018). From this point of view, the nature of the assessments – which signs or samples are taken as predictors – might also alter (Sarmiento et al., 2018).

Another reason for the difficulty of longer term predictions lies in the theories of motor learning and development. Cognitive and motor skills are intertwined and develop through dynamic interactions with the environment (e.g. Davids, Button, & Bennett, 2008; Newell, 1991; Newell, Liu, & Mayer-Kress, 2001; Thelen & Smith, 1994; Van Geert, 1994). Across time, rates of change in performance and performance characteristics rarely follow a linear trend and evolve at different time scales (Newell et al., 2001). As a consequence, individual athletes often follow unpredictable, nonlinear developmental trajectories, which likely poses limits on the possibility of long-term performance predictions (e.g. Abbott et al., 2005; Den Hartigh, Van Yperen, & Van Geert, 2017; Phillips et al., 2010; Sarmiento et al., 2018). The outcomes of the selection procedure, and the consequences of these outcomes, should thus be considered in light of the time scale at which one aims to predict performance. Altogether this means that, in order to advance selection procedures, one should utilise (a) current knowledge from selection psychology and (b) theories of learning and development across time. In the current paper, our primary focus was on the evaluation of current selection procedures in sports given what we know from the selection psychology literature. From this

perspective, using actuarial judgment and sample tests will likely lead to more accurate and valid predictions of athletes' future performance, certainly on the short term.

Disclosure statement

No potential conflict of interest was reported by the authors.

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